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SCIENTIFIC NOTE

COCOA POD (*THEOBROMA CACO*)—A POTENTIAL BREEDING HABIT OF *AEDES ALBOPICTUS* IN DENGUE-SENSITIVE KERALA STATE, INDIA

J. HIRIYAN[1] AND B. K. TYAGI[1,2]

ABSTRACT. *Aedes* (*Stegomyia*) *albopictus* (Skuse), a potential dengue vector, particularly in the foot-hill areas of the Western Ghat region of Kerala State has been found breeding for the first time in cocoa pods (*Theobroma cacao*) in India. Breeding in cocoa pods is considered an opportunistic adaptive behavior of the mosquito to maintain density in the absence of common breeding sites, especially latex-collecting cups in rubber plantations, during the monsoon periods. Vector breeding in cocoa pods was observed up to 8 m from the ground, and in both hanging and grounded pods, whose endocarp had been devoured by rodents. *Ae. albopictus* breeding in cocoa plant is discussed in relation to accentuating disease transmission risk.

KEY WORDS *Aedes albopictus*, breeding, cocoa pods, Kerala State, India

Dengue and dengue hemorrhagic fever occur throughout the tropics (Gubler and Kuno 1997), although in recent years, disease incidence has apparently been increasing in the southeast Asian region, including India. Throughout the world, *Aedes aegypti* (L.) is the primary vector of dengue, adequately supported by the Asian tiger mosquito, *Ae. albopictus*, in increasing disease transmission to epidemic proportions. *Aedes albopictus* is well known to supplant *Ae. aegypti* in nature and can become a serious epidemic vector of dengue/dengue hemorrhagic fever, particularly in the absence or scarcity of *Ae. aegypti* (Anon. 1994, Spielman and D'Antonio 2001). Additionally, its epidemiological significance is heightened due to its potential to transmit dengue virus vertically (Metselaar et al. 1980, WHO 1999, Pant and Self 1999). *Aedes albopictus* is an opportunistic container breeder and is capable of utilizing natural as well as artificial container habitats. It has the ability to adapt to a wide range of confined water sources and is known for its ability to survive in very small collections of water, requiring only a quarter inch of depth to complete its life cycle.

In India, although dengue epidemics transmitted by *Ae. aegypti* have been occurring now and then since 1963, dengue virus (DEN-4) was detected from *Ae. albopictus* for the first time in the late 1980s in Asansol, West Bengal (Reuben et al. 1988). Recently, however, dengue virus infection in *Ae. albopictus* has been detected in the foot-hill areas of the western slopes of the Western Ghat region, which has suffered from epidemics for some years (Tyagi et al. 2002; Hiriyan et al., unpublished observations). There, *Ae. albopictus* is mainly a forest-edge species adapted to rural, suburban, and urban environments, breeding in tree holes, bamboo stumps, and leaf axils in the forest and in artificial containers in suburban and urban areas. It is alarming to note that, in Kerala State, which has been experiencing a spate of dengue epidemics for the past 3 years, culminating in as many as 1,501 cases and 58 deaths by mid-2003, *Ae. albopictus* (the most common vector species) has been reported to be breeding in a variety of habitats, mainly latex collecting cups in rubber (*Hevea brasiliensis*) plantations.

During a recent dengue epidemic investigation, we chanced upon the rare phenomenon of *Ae. albopictus* breeding in cocoa pods (*Theobroma cacao*), both hanging on trees as well as grounded, supporting profuse oviposition at different elevations (Fig. 1). Cocoa trees are grown in Kerala State along with rubber plants across the western slopes of the Ghat mountains. Cocoa plantations, though much sparser and fewer, are spread over 8,412 ha compared with 448,988 ha of rubber. The mosquito bred in rodent-bored cocoa pods still hanging intact on the tree (Fig. 2). Breeding of *Ae. albopictus* in cocoa pods invites special attention because this phenomenon occurs invariably during the rainy season, when the more preferred sites (latex collecting cups) are rendered unsuitable for breeding because they are covered with plastic canopies. Thus, cocoa pods provide an alternative breeding site for this vector species in the absence of the preferred sites, helping it to survive. Although accurately determining larval population dynamics of *Ae. albopictus* in cocoa pods was constrained by several factors, including inaccessibility and enormous quantities of pods, 3 hanging cocoa pods (app. 5 m) and 4 pods on the ground were examined for breeding, of which 6 were found positive for immature stages of *Ae. albopictus*. The occurrence of *Ae. albopictus* in cocoa pods on the ground (62.5%)

[1] Centre for Research in Medical Entomology, No. 4, Sarojini Street, Chinna Chokkikulam Madurai 625 002, TN, India

[2] To whom correspondence should be addressed.

Fig. 1. Cocoa tree with pods, showing some with rodent-gnawed holes.

Fig. 2. Rodent-bored cocoa pod showing site of *Aedes albopictus* breeding.

was found to be only second to breeding in latex collecting cups (84.3%) (Tyagi et al. 2002). Cocoa pods were examined for mosquito breeding from May 2003 through January 2004, covering the 2 monsoons in Kerala state, i.e., May–July and October–December. The endocarp of cocoa pods appeared to have been eaten up by the rodent through its maturity, following which the hollowed pod remained hanging for over 6 months, collecting rainwater and mosquito breeding in the process. Immature stages in each pod were counted, staged, and identified. On average, 25 immature stages were present per pod; I/II-stage larvae (36%), III/IV-stage larvae (58%), and pupae (6%). Some of the hanging rodent-bored pods positive for mosquito breeding contained at least 20 ml of rainwater. To sample inhabitants of the pods, these were flooded with water to allow immature stages to be picked up and eggs to hatch subsequently. *Armegeres subalbatus* was observed breeding early in pods when rainwater was quite fresh.

This is the first report of cocoa pod-breeding *Ae. albopictus* in India and may have a significant impact on dengue epidemiology in Kerala State. However, certain other mosquitoes' predilection for breeding in cacao husks has been reported in other countries. Lounibos and Machado-Allison (1983, 1986) studied oviposition, egg brooding, and development of *Trichoprosopon digitatum* in Venezuela, whereas Lounibos (1983) and Laird (1988) had examined breeding habits of *Eretmapodites chrysogaster* in cacao husks in Africa. Some species of *Aedes* have been recorded from cacao husks in the Oriental region (Baisas and Ubaldo-Bagayon 1952, Laird 1956). Lounibos and Machado-Allison (1983) have age-graded cacao husks to quantify the changes in this microhabitat through time. It has been emphasized that the types of mosquitoes that successfully develop in this microhabitat are influenced by the age and state of husk decay. Fruit husk specialists, such as *T. digitatum* and *E. chrysogaster,* thrive in the soupy ooze of decaying endocarp (Lounibos 1983), but more generalist container occupants of the genera *Aedes* and *Culex* occupy husks only in later stages of degradation. Laird (1988) has described an analogous sequence of occupancy of decaying coconut husks, first by *Armigeres* sp., then by container generalists, such as *Ae. albopictus.*

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